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Thermal analysis of internal condensation process in a horizontal tube of falling film evaporation

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ABSTRACT

Internal condensation in a horizontal tube of falling film evaporation is of great importance in the process of low-temperature multi-effect distillation (LT-MED). Thermal analysis of internal condensation in a horizontal tube is investigated within the practical operating parameters in a LT-MED desalination plant. The analysis takes into account of the effect of interfacial shear, axial pressure gradient, saturation condensation temperature, heat transfer temperature difference, and non-condensable gas (NCG) on heat transfer characteristics of internal condensation. It is done to obtain the exact correlations that different methods to calculate axial pressure drop gradient and heat transfer coefficient are compared. The results indicate that reducing condensation temperature and increasing temperature difference contribute to improving the condensation rate of unit length for certain values of the tube length and inlet steam velocity, and that the tube length depends on the heat transfer temperature difference. The analytical results also show that the effect of interfacial shear stress on condensation rate is important while that was usually neglected in previous research, and that very small mass fraction of NCG can significantly increase the tube length as the presence of NCG reduces local temperature difference along the tube length. Besides, an increase in tube length compensates the negative effect of interfacial shear stress and NCG on internal condensation.

Keywords: Internal condensation; Axial pressure drop gradient; Non-condensable gas; Horizontal tube of falling film evaporation; Tube length

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